Planning and Implementing a Research Study

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TABLE OF CONTENTS

I. Introduction 3

II. Planning and Implementing a Research Study. 3

A. Purpose of study 3

B. Types of research studies 3

C. Study approach 4

D. What type of study should I do? 5

1. Information or Literature Search. 5

2. Meta-analysis. 5

3. Retrospective or Prospective Study 5

4. Operational Trial Protocols 7

III. Research Protocol and Study Life Cycle 8

Stage 1: Identify need for a study 8

Stage 2: Design study 8

Stage 3: Establish the study 8

Stage 4: Maintain the study 9

Stage 5: Analyze the data 9

Stage 6: Prepare progress (if necessary) and final reports and archive data 9

Stage 7: Communicate the results 9

Stage 8: Wrap-up the study and evaluate the outcome 9

IV. Assessing Research Studies - Exit Evaluations 9

V. References and Resources 10

A. General Statistical References on the Design and Analysis of Research Studies 10

B. Operational Trial Protocols 11

C. Adaptive Management 12

D. Publications from the Biometrics Unit, Research Branch, BC Ministry of Forests 13

Appendix 1: Checklist for Design of a Proposed Study 15

Appendix 2: Checklist for an Exit Evaluation of a Completed Project 17

Appendix 3: Research Study Worksheet 19

Appendix 4: Study Life Cycle Overview 22

I. Introduction

Research guidelines can help guide the proper conduct and execution of a quality research study. This document includes a list of steps or procedures vital to any research project and two useful "check-lists" (Appendix 1 and 2) that can be used to help design research proposals and evaluate completed projects.

This protocol will use a broad definition of a research study: an organized investigation of some question(s) that can be answered by the collection and analysis of appropriate information. If the research follows proper design and analysis principles, as outlined in this protocol, the results will provide reliable information for use in forest management decisions. A basic tenet of good research is that its results can be confirmed by the results of similar studies.

II. Planning and Implementing a Research Study.

A. Purpose of study

Determining the purpose of the study may be the most important step as it provides the foundation for the study's design and analysis of the resulting data. Since there are so many variables that need to be considered it is rarely easy to design a study to answer what appears to be a simple question. Considerable time may be needed to develop an objective that is clear, specific, and describes the population to which results are to be inferred. The objective should also include a discussion of the threshold or difference between treatment levels that is biologically and/or operationally significant.

The objective may have to be restricted in scope by logical and resource limits. Further, an iterative process may develop as issues brought up when working through the design require reexamination of the objective. Sometimes the objective may need to be changed or refined and at other times, the objective will inform the direction that the design should take.

B. Types of research studies

Research studies can be categorized in several ways. The following categories are arbitrary and individual studies may straddle or combine several categories.

Studies may be **prospective** or **retrospective**. The purely experimental approach is usually prospective since an experiment is set up and then we wait for the results. Retrospective approaches try to use information that is already available or subject matter that has already been treated to find treatment differences. Literature searches and meta-analyses are retrospective in nature since they work with information that is already available. Observational and sampling studies may be either prospective or retrospective.

The question may be **operational** in nature. In this case, studies are intended to help determine which of two or more possible management actions will produce a desired outcome. The intent is to consider changing management practice. Promising applied research results are often tested

for regular use with **operational trials**. **Adaptive management trials** more directly involve the operational manager in study design and implementation than do many operational trials.

Scientific studies focus more on understanding the process that might "cause" the different outcomes. This usually requires that the study be able to find smaller treatment responses. Further distinctions can be made between **pure** and **applied** scientific research depending upon how directly relevant the topic is to current operational problems. Many applied scientific research studies might also be called operational trials.

C. Study approach

Study approaches may include one or more of the following activities:

- **Information Search.** An information **search** (or, commonly, a literature search) can be undertaken to collect and evaluate published and unpublished information on the subject matter of interest. While this is a significant step in the design stage of any research study, this work alone may answer the question at hand.
- **Meta-analysis.** This approach extends the information search into a data analysis study. The results of many similar studies addressing a similar question are combined to produce an overall conclusion.
- **Sampling.** The **sampling** approach aims for representation of the subject matter under investigation (and may also be known as **descriptive sampling**). This is done by identifying a population to which inferences are to be made, creating a matching frame or population list and then randomly choosing a sample of members or study units from that frame or population list to measure the response variables of interest. Random selection of study units provides the statistical foundation for making inferences beyond the sample to the whole population (scope of inference). The population may be divided into strata. When differences between strata are of interest, this may be called an **analytical survey**.
- **Experiment.** The familiar **experimental** approach controls at least some of the variables under investigation. Usually this is done by randomly assigning treatments to the subject matter under investigation. Treatment assignments are designed so that uncontrolled variables are expected to affect each treatment in a similar manner. This rigorous approach provides some justification for making cause and effect statements when discussing the study's conclusions.
- **Observation.** The **observational** approach tries to study the subject matter *in situ* so that a greater measure of realism is attained. This is done by finding subject matter that differ only by the variable of interest however this difference may have arisen, and looking for corresponding response variable differences. The lack of random selection of study units and/or random assignment of treatments to study units, limits the study's scope of inference and the strength of any cause and effect statements.

D. What type of study should I do?

The worksheet in Appendix 3 will help you assess what type of research study[1] is best suited to answer your question[2]. Having a clearly defined and bounded question will ease the whole process and may be the most important step. The possible outcomes include:

1. Information or Literature Search.

Have you reviewed all relevant information relating to the problem? It is possible that others have already answered your question. Before starting a research study, you need to do sufficient background research to justify that it is necessary and feasible.

2. Meta-analysis.

Meta-analysis is a set of statistical procedures designed to accumulate experimental and correlational results from independent studies that address a related set of research questions. It is the statistical analysis of results from a variety of individual studies for the purpose of integrating the findings. Do you know of other studies that have been carried out that address your question? Could you combine the results of these studies to answer your question?

To enable others to include your research results in a meta-analysis, it is critical that results be documented and archived so others can leverage the results of your study.

3. Retrospective or Prospective Study

A retrospective or prospective study is one of:

- Operational trial
- Adaptive management trial
- Pure or applied scientific study

And which uses one or more of following approaches:

- Descriptive Sampling
- Analytical sampling
- Experiment
- Observation

The choice of approach affects the reliability and predictive value of your study and influences how the study will be conducted, what sort of questions it can answer, and how the data will be analyzed. When deciding upon the approach to take for a retrospective or prospective study (step 9 on the worksheet), it is important to consider the following three questions.

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[1] Discussion of how to design a research program which might include a variety of research studies is beyond the scope of this protocol (but see, for instance, Box, Hunter and Hunter, 1978, section 1.4).

[2] See Table 9.1 in Sit and Taylor (1998) for an alternative approach. Notice that demonstrations are not considered a type of research study.

i. What sampling approach will be used?

Sampling theory was developed to estimate the value of a selected variable either over the whole population and/or for strata (subsets) within the population (**descriptive sampling**). A proper sample design allows the results from a sample to be *generalized* to the whole population and/or subsets of the population.

a) Define the population of interest (e.g. 20-year old lodgepole pine on dry SBS sites) and to which the study's results are to be generalized. Is the goal to provide a measurement of tree heights on a particular site, or to estimate heights that might be observed on other similar sites?

b) List all the possible sampling units (at least theoretically). This is known as a frame and it may include information on observed variables about the units (e.g. BEC zone, elevation, aspect, and previously applied treatments) that could be used to identify strata for the sampling procedure (known as post-stratification for retrospective studies). If comparisons between strata are of interest then the design is an **analytical survey**.

c) Select sampling units to include in the study using a suitable, properly randomized procedure.

ii. What experimental approach will be used to control effects of extraneous variables?

Experimental design methods allow precise comparisons between treatment responses by either directly controlling extraneous variables or by randomizing out their influence. Variables with only a few levels, such as species or gender, are usually referred to as factors.

a) Define the treatment and classification variables or factors that may "explain" or predict subject matter responses. Treatment factors are usually of most interest and can often be assigned to the study material at the researcher's discretion. Classification factors are usually of less interest and can only be observed by the researcher. They are often included because they help explain different responses between units of the study material. The strata described above in the sampling approach are usually classification factors.

b) Identify (or create) the units of the study material which will be assigned different levels of the treatment or will be observed to have different levels of the classification variables.

c) Assign levels of treatment factors to study units using a suitable, properly randomized procedure that takes into account the levels of the classification variables (and/or strata).

iii. Will the subject material be studied in situ?

An observational study is a controlled investigation where the primary focus is on studying the subject matter in its natural setting. This may be because of the objective or because of the difficulty in studying the subject in any other way. For instance, deer or root rot may need to be studied where they exist as they are difficult to sample and/or assign to location or treatments.

a) The population of interest should be clearly defined. The limits of non-randomized subject matter selection must be carefully considered.

b) Possible predictor or explanatory variables need to be identified. The consequences of how variable levels became associated with subject matter units must be carefully considered.

Managing the many possible 'explanatory' variables

These approaches have different types of objectives that lead them to manage the many possible 'explanatory' variables differently. Nevertheless, any study may combine one or more of these three approaches thus using many different methods for managing the many possible explanatory variables. These methods, regardless of approach, include:

1. Blocking or stratifying the study material according to classification factors into 'homogeneous' groups. These blocks or strata need not be physically contiguous;
2. Random selection of study units from the population of interest. This reduces possible bias in the selection procedure so that selected units are expected to represent the population. The random selection procedure may be restricted by, for instance, requiring separate sampling schemes within each stratum.
3. Random assignment of treatment levels to study units so that uncontrolled and unknown variables are expected to affect the response to each treatment level in a 'similar' manner. If blocking or stratification is used then the random assignment may be restricted so that each treatment level is represented within each block or stratum;
4. Limiting the study to one level of a known classification factor. This limits the scope of inference for the study to just that level;
5. Explicit inclusion in the design, either as a factor in the design or by confounding its levels with blocks; and
6. Explicit inclusion in the data analysis model, such as when a continuous variable is used as a covariate.

4. Operational Trial Protocols

Section V-B includes a list of currently published operational trial protocols which may be helpful in providing additional and more detailed information. For instance, although Leadem et al (1997) was written specifically for field studies of seeds, this manual is a good general guide to the principles and cautions underlying the design of short- and long-term field studies. Section 1 stresses the importance of planning and discusses the essential components of successful field studies: designing a field study (hypothesis, objectives, factors, methods, schedule, test conditions); experimental design (basic concepts, sample size); data management; selecting and describing the study site; analyzing and interpreting the data; and research site administration. Section 2 discusses how to design an environmental monitoring program, and describes various methods for measuring light, temperature, moisture, wind, and canopy cover. Sections 3 to 8 provide comprehensive background and methods for studying seed production (this section includes several detailed case studies), dispersal, predation, seed banks, seed quality, and the effects of silvicultural practices on germination.

III. Research Protocol and Study Life Cycle

A research protocol applies to all phases of a research study. It covers the basic elements that form part of a well-managed project from conception to completion—the study life cycle. The research protocol considers the typical research study as a set of discrete stages or elements in its life cycle. Each of these elements requires attention in project design and implementation, with documentation occurring at all stages. A table summarizing the stages discussed below is provided in Appendix 4.

Well-documented research studies have a greater potential for future unanticipated usefulness. While documentation can appear unnecessarily onerous, doing it well is very important. Consider the following general principle: If your study leader was unable to complete the study, would someone new to the project be able to bring the study to an effective completion? What would you need to know if you were that "new" person? While reports can be brief, they should contain complete descriptions of what was done along with maps, photos and other useful pieces of information.

Individual research studies may have additional stages, as influenced by the degree of complexity and specific objectives, however, every study should address all of the following criteria.

Stage 1: Identify need for a study

At this stage we investigate whether a research study will be necessary. This is done by identifying a subject area and choosing a research question or questions. Research projects should address significant gaps in current knowledge that have been highlighted either as part of a research strategy or through background assessment by the project proponent.

Stage 2: Design study

All research should be guided by a working plan. Working plans should address the following:

- Background / Justification
- Objectives
- Methods and Procedures
- Research Team and their responsibilities
- Statistical design and proposed analyses
- Budget
- Milestones

The Ministry of Forest Research Program has developed a series of biometrics pamphlets to assist at this stage[3] but they don't cover ALL of the required topics.

Stage 3: Establish the study

The working plan is implemented by establishing the study and preparing an establishment report. This report should include maps and a full description of any changes from the working plan that were required during the field work.

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[3] (http://www.for.gov.bc.ca/research/biopamph/) See, especially pamphlet # 44.

Stage 4: Maintain the study

Some studies operate over a long term. The study site(s) should be maintained, and any changes to the site measured and documented. Notes maintained in a project diary may be essential to interpreting study results in the future. Collect data and check data for obvious errors. Data should be corrected as soon as possible after data collection. All data should be properly documented and archived for future use.

Stage 5: Analyze the data

Collected data is cleaned, organized, entered into a database and analyzed.

Stage 6: Prepare progress (if necessary) and final reports and archive data

Describe project and summarize results. Discuss whether the objectives were met and what conclusions can be made. Prepare final report and archive the final version of the data. Final reports should document the management implications. Results should be reported even if they are inconclusive or contrary to expected outcomes.

Stage 7: Communicate the results

All studies should include an extension plan. Working plans should describe how the study findings will be disseminated. This can include workshops, web pages, and extension notes. The final report should be published or made available to interested parties through a website or other means. Metadata about the project could be registered on a searchable database such as the Natural Resources Information Network[4].

Stage 8: Wrap-up the study and evaluate the outcome

Provide a brief evaluation of what you could have done better and record that on the project file so others might benefit from what you have learned. Clearly identify what actions are necessary to terminate the project or to undertake future site maintenance and re-measurement. You should also complete an exit evaluation for major projects.

IV. Assessing Research Studies - Exit Evaluations

All research studies should receive a post-completion review. In addition, some funding sources may stipulate that completed or abandoned research studies may also be subjected to an audit. The audit may be especially useful for abandoned research studies or studies that have not passed through a pre-approval or review process. The objective of either form of exit evaluation will be to determine:

1. If the study was conducted in a reasonable manner given the circumstances;
2. If the study produced useful information (including any lessons from unexpected events, lack of expected response, and/or plans that went awry for whatever reason); and
3. If the study results are or should be made available to interested parties.

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[4] The current WEB site for NRIN is http://nrin.siferp.org/ .

The evaluation should include review of project reports and possibly other documentation as described in Appendix 3. It should address any questions required to understand clearly why the study was undertaken, how it was conducted, how the final conclusions were arrived at, and whether it has correctly followed a study protocol identified in the work plan. The latter is especially important if results from similar but independent studies are to be combined. It should also assess whether the final conclusions drawn are supported by the study and the discussion in its final report.

A proposed exit evaluation review sheet is in Appendix 2. The list of "questions to consider" for each objective should not be considered exhaustive: they provide some sense of what should be considered when assessing that objective.

V. References and Resources

Excellent resources readily available include Sit and Taylor (1998), Stafford (1985) and many of the pamphlets and handbooks produced by the Biometrics Unit, Research Branch, BC Ministry of Forests (see section D below). Many operational trial protocols have been developed which provide more detailed guidance. These are listed in section B.

A. General Statistical References on the Design and Analysis of Research Studies

Box, George E. P., William G. Hunter, and J. Stuart Hunter. 1978. Statistics for experimenters: An introduction to design, data analysis and model building.
– a good introductory text with a slant towards industrial manufacturing problems

Cochran, William G., and Gertrude M. Cox. 1957. Experimental designs, 2nd ed. John Wiley & Sons, NY, NY, USA.
- a "bible" of balanced designs

Green, Roger H.1979. Sampling design and statistical methods for environmental biologists. John Wiley & Sons, NY, NY, USA

Kish, Leslie. 1987. Statistical design for research. John Wiley & Sons, NY, NY, USA

Kleinbaum, David G., Lawrence L. Kupper, and Hal Morgenstern. 1982. Epidemiologic research: Principles and quantitative methods. Van Nostrand Reinhold, NY, NY, USA.

Kuehl, Robert O. 1994. Statistical principles of research design and analysis. Duxbury Press, Wadsworth Pub. Co., Belmont, CA, USA.

Little, Thomas M., and F. Jackson Hills. 1978. Agricultural experimentation: Design and analysis. John Wiley & Sons, NY, NY, USA.
- a good straightforward introduction to trial design and data analysis.

McPherson, Glen. 1990. Statistics in scientific investigation: Its basis, application and interpretation. Springer-Verlag, NY, NY, USA

Mead, R., R. N. Curnow and A. M. Hasted. 1993. Statistical methods in agriculture and experimental biology., 2nd ed. Chapman & Hall, NY, NY, USA
- general introduction to design and data analysis.

Sit, V. and B. Taylor (editors). 1998. Statistical methods for adaptive management studies. Res. Br., BC Min. For., Res. Br., Victoria, BC Land Manage. Handb. No. 42.

Snedecor, George W., and William G. Cochran. 1980. Statistical methods, 7th ed. The Iowa State University Press, Ames, Iowa, USA
- a good general compendium. May be newer editions out now.

Sokal, Robert R., and F. James Rohlf, 1981. Biometry, 2nd ed., W. H Freeman & Co., San Francisco, CA, USA.
– a good general compendium. Discusses ideas in some depth.

Stafford, Susan G. 1985. A statistics primer for foresters. Journal of Forestry. pp 148-157.
– includes a very brief but excellent introduction to trial design.

Steel, Robert G. D., James H. Torrie, David A Dickey. 1997. Principles and procedures of statistics: A biometrical approach, 3rd ed., McGraw-Hill, NY, NY, USA
– a good general compendium

Wetherill, G. Barrie. 1981. Intermediate statistical methods. Chapman & Hall, NY, NY, USA
- more mathematical than "introductory" texts but much more readable than most non-introductory books.

B. Operational Trial Protocols

Biring, B.S., P.G. Comeau, J.O. Boateng, S.W. Simard. 1998. Experimental design Protocol for Long-Term Operational Response Evaluations (EXPLORE). Res. Br., Min. For., Victoria, B.C. Work. Pap. 31/1998.
WEB site: http://www.for.gov.bc.ca/hfd/pubs/docs/wp/wp31.htm

Habitat Monitoring Committee. 1990. Procedures for environmental monitoring in range and wildlife habitat management. Draft edition version 4.1. B.C. Min. Environ. and B.C. Min. For., Victoria, B.C. 196 p.c

Hays, W. 1990. Operational monitoring in the Prince George Forest Region. B.C. Min. For., Prince George Region, Prince George, B.C.

Herring, L.J. and J.C. Pollack. 1985. Experimental design protocol for forest vegetation management research: Level B trials (first approximation). B.C. Min. For. Internal Report (unpublished).

Leadem, Carole L, Sharon L Gillies, H Karen Yearsley, Vera Sit, David L Spittlehouse, Philip J Burton. 1997. Field Studies of Seed Biology. Res. Br., Min. For., Victoria, B.C. Land Mange. Handbook 40/1997.
WEB Site: http://www.for.gov.bc.ca/hfd/pubs/docs/lmh/lmh40.htm

[NIVMA] Northern Interior Vegetation Management Association. 1990. Unified system of silviculture monitoring. Prince George, B.C.

[NIVMA] Northern Interior Vegetation Management Association. 1996. TRENDS: Treatment regime evaluation - Numerical decision support field manual. Prince George, B.C.

Pollack, J.C. and L.J. Herring. 1985. Experimental design protocol for forest vegetation management research: Level A trials (first approximation). B.C. Min. For. Internal Report (unpublished).

Silviculture Working Group. 1997. Growth and yield silviculture monitoring. Recommendations for sampling methods and a summary of main issues. Rep. To the Growth and Yield Monitoring Task Force Mesachie Lake meeting. June 17-19, 1997. B.C. Min. For., Victoria, B.C. (unpublished)

Simard, S.W. 1993. PROBE: Protocol for Operational Brushing Evaluations (First Approximation). B.C. Min. For., Victoria, B.C. Land Manage. Rep. No. 86.
WEB Site: Whole document not available but description is available at:
http://www.publications.gov.bc.ca/queries/ShowPubDetail.asp?PUB_Seq_Num=447531&PUB_Publication=7610000072

Thrower, J.S & Associates, Ltd. 1999. Interim report: Monitoring growth and yield of treated stands. Report prepared for B.C. Min. For., Resources Inv. Br. by J.S. Thrower & Associates Ltd.

C. Adaptive Management

Ministry of Forests. 1999. An Introductory Guide To Adaptive Management. [Online]: http://www.for.gov.bc.ca/hfp/amhome/introgd/toc.htm

Sit, V. and B. Taylor (editors). 1998. Statistical methods for adaptive management studies, Res. Br., BC Min. For., Res. Br., Victoria, BC, Land Manage. Handb. No. 42.: http://www.for.gov.bc.ca/hfd/pubs/docs/lmh/lmh42.htm

D. Publications from the Biometrics Unit, Research Branch, BC Ministry of Forests

a) Published Handbooks. Available for download as PDF files.

Handbook #	Title
1	Pictures of linear models (1991)
2	Power analysis handbook for the design and analysis of forestry trials (1991)
3	Guidelines for the statistical analysis of forest vegetation management data (1992)
4	Catalog of curves for curve fitting (1994)
5	Analyzing ANOVA designs (1995)
6	Analysis of repeated measures and time series: an introduction with forestry examples (1996)
7	Introduction to logistic regression models with worked forestry examples (1996)

b) Biometrics Pamphlets. Many of these are also available for downloading as PDF files. The general WEB site is: http://www.for.gov.bc.ca/research/biopamph/

Pamphlets listed below may be of particular interest.

02 The importance of replication in Analysis of Variance

05 Understanding Replication and Pseudo-replication

06 ANOVA: using Plot means

11 Sample Sizes: for one mean

14 ANOVA: Factorial designs with a separate control

15 Using SAS to obtain probability values for F-, t- and X^2-statistics

16 ANOVA: Contrasts viewed as t-tests

17 What is the Design?

21 What are Degrees of Freedom?

22 ANOVA: Using a hand calculator to test a one-way ANOVA

23 ANOVA: Contrasts viewed as correlation coefficients

25 ANOVA: The Mean Within Sums of Squares as an Average Variance

30 Interpretation of probability p-values

31 ANOVA: The Linear Models behind the F-tests

34 When are blocks pseudo-replicates?

37 A general description of hypothesis testing and power analysis

44 What Do We Look for in a Working Plan?

48 ANOVA: Why a fixed effect is tested by its interaction with random effect

53 Balanced Incomplete Block (BIB) Study Designs

55 Displaying Factor Relationships in Experiments

Appendix 1: Checklist for Design of a Proposed Study

Justification	Yes	No	Comments
1. Is the study objective clearly stated?			
2. Does the objective address an identified knowledge gap or describe a new knowledge gap?			
3. Has background information been reviewed sufficiently to demonstrate the utility of the objective?			
Study Design and Working Plan			
4. Does the methods section include a clear description of how the study will be implemented? Will the methods proposed allow the objective to be met?			
5. Does the methods section include an analysis plan for the data?			
6. Are researchers with sufficient expertise involved in the project? Has the working plan been reviewed by others knowledgeable in the subject area and/or in study design?			
7. Is there a list of significant milestones with proposed completion dates? These would include when the study would be established, when data would be collected and what final results/extension vehicles are planned and when they would be completed.			
8. Is there a list of duties for those involved in the study?			
9. Does the plan include a budget?			

10. Does the working plan address issues relating to future actions for any study sites (e.g., site maintenance and re-measurement)?			
Reporting, Information Management and Communications			
11. Does the plan include provisions for communicating results, including publication or creation of an alternative form of publicly available report?			
12. Does the study include the delivery of extension products?			
13. Does the study make provisions for the archiving of information?			
Summary of Appendix 1			
14. Does the project in general represent a well-conceived and well-designed initiative that will advance knowledge?			

Appendix 2: Checklist for an Exit Evaluation of a Completed Project

Conduct of the Study	Yes	No	Assessment/Comments
1. Was the objective clearly described?			
2. Did the design and implementation allow that objective to be met?			
3. Was the study conducted in a reasonable manner?			
4. Was the study well-documented with a working plan, establishment report, and project diary?			
5. Was the study implemented as described in the working plan? Were mid-stream changes made in an appropriate manner?			
Value of Results			
6. Did the study produce useful information?			
7. Is the final report complete and clearly written?			
8. Are the results and conclusions supported by the study methodology?			
9. Does the information obtained answer the original objective of the study? If not, was this due to some event or outcome that should have been anticipated? Or did something unexpected occur?			
10. Does the final report compare this study's results with those of other studies and/or research?			
11. Are the results useful and applicable to making management decisions?			

Communication & Extension			
12. Are the results available to all interested parties?			
13. Have communication and extension activities been undertaken to aid in incorporating project results into sustainable resource management practices and decisions?			
Abandoned Projects			
14. Was the study abandoned for good reason? (Identify cause such as poor design and/or planning, withdrawal of funding support, change of management priorities, other factors)			
15. Is there a report that documents experiences gained from the abandoned project?			
16. Has information gathered during the course of the project been properly archived?			
Summary of Appendix 2			
17. Has the project been completed in a satisfactory manner, or abandoned with proper documentation?			

Appendix 3: Research Study Worksheet

Step	Action	Now what do I do?
1	Define Objective/Question (be as specific as possible)	Go to Step 2
2	Collect Current Information (Information/Literature Search):	
	i) If this answers the question then research is:	Done (Go to Step 10)
	ii) If material needs synthesis before any conclusions can be drawn:	Go to Step 3
	iii) If there is not enough information then have an information gap:	Go to Step 4
3	Synthesize current information:	
	• If synthesis of information straightforward then:	
	i) If this answers the question then:	Done (Go to Step 10)
	ii) If there is not enough information then have an information gap:	Go to Step 4
	• If information synthesis is not straightforward then:	
	i) If there are several studies already addressing your question then consider whether a Meta-analysis would be appropriate:	Go to Step 4
	ii) If lots of information are available then consider whether it could be used effectively for a retrospective analysis:	Go to Step 4
	iii) If there is not enough information then have an information gap:	Go to Step 4
4	Summarize results of Information Collection and Synthesis. (If substantial this might be a Problem Analysis Report).	Go to Step 5
5	A research study of some kind is required. Redefine objective of study in light of new information – make it as specific and clear as possible. Specify the scope of inference.	Go to Step 6

6	Decide whether a meta-analysis, retrospective or prospective study is appropriate: In step 3, was it decided that a meta-analysis or retrospective study would be appropriate and useful? If yes, then: If no, then:	 Go to Step 6a Go to Step 6b
6a	Would a meta-analysis or retrospective study provide interim or final answers? If interim then: If final then:	Design this study and a prospective study. Go to Step 6c Design a meta-analysis or retrospective study. Go to Step 7
6b	Study will have to be prospective if current information is not adequate or can only provide interim answers.	Go to Step 7
7	**Circle which type of study(s) will be done:** Meta-analysis or Retrospective or Prospective Study	 Do Study Go to Step 8
8	Decide upon type of retrospective or prospective study: Is objective primarily concerned with choosing between management actions/options? No Yes	 Go to Step 8a Go to Step 8b
8a	Objective is primarily "scientific" so that the science behind the processes involved are of most interest. If the objective is primarily focussed on increasing scientific knowledge as background for developing management choices then this is **applied research**.	Involve a research scientist and Go to Step 9

8b	Will management be directly involved in learning from the outcome of an operational program using one or more different management actions? Yes No	Design an Adaptive Management Trial Go to Step 9 Design an Operational Trial Go to Step 9
9	Determine which study approach will be used by answering the following questions (more than one 'yes' is possible). The three approaches are briefly discussed in Section 3 to help you determine the appropriate answer. 1) Sampling approach (representation): Will sampling be used to obtain material for the study? 2) Experimental approach (control): Will variable levels be randomly assigned to the study material? 3) Observational approach (realism): Will the subject material be studied *in situ*?	
10	Summarize Results – Study Characteristics will be (circle at least one from the first row, and one each from the following rows if a prospective or retrospective study was selected):	

Literature Search	Meta-analysis	Retrospective	Prospective
Operational Trial	Adaptive Management	Applied Science Study	Pure Science Study
Observational	Descriptive Sampling	Analytical Sampling	Experimental Approach

Appendix 4: Study Life Cycle Overview

STUDY LIFE CYCLE STAGE	Documentation
1) IDENTIFY NEED FOR STUDY: Identify an information gap and conduct an information/literature search to determine current information availability.	Problem Analysis (formal report optional)
2) DESIGN: develop objective and design the study. Careful thought and discussion with others knowledgeable in the subject area and in study design can be very helpful. Careless work here can completely undermine a study regardless of how well the other stages are implemented.	Working Plan
3) ESTABLISH: put the plan into operation. Modifications to the original design/plan often occur here. If done incorrectly, usefulness of the study may be seriously undermined. Make sure that any such changes are noted. Preserve study by appropriately registering its existence.	Establishment Report (may be unnecessary for "armchair" studies)
4) MAINTAIN: Check that study site(s) are okay and note changes, such as deer browse levels, brush competition, etc. Collect interim measurements as scheduled and safely store. Check data for obvious errors since it is easier to find typing errors etc. now, rather than later.	Project Diary (not a formal report but notes made here can be essential to interpreting trial results)
5) ANALYSE: Collected data is "cleaned", summarized and analyzed. Data should be archived.	Formal report possible but not necessary
6a) REPORT: Longer-running studies may benefit from interim reports which describe how the study is progressing.	Progress Report (optional)
6b) REPORT: Describe the outcome of the study including relevant management implications. Results should be reported even if they are inconclusive or contrary to expected outcomes.	Final Report
7) EXTENSION: Disseminate study results using workshops, WEB pages, extension notes, etc.	Whatever is appropriate
8) WRAP-UP: Ensure that there aren't any 'loose ends' pertaining to the research site or possible future data collections. Clearly identify what actions are necessary to terminate the project or to undertake future site maintenance and re-measurement.	Site protection designation or release. Follow-up action plan. Exit evaluation for major projects.